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(71) Applicants
Morgan Refractories
Limited,
Liverpool Road, Neston,
South Wirral, Cheshire,
L64 3RE
(72) Inventor
Ernest Peter Chadwick
(74) Agents
Phillips & Leigh,
7 Staple Inn, Holborn,
London WC1V 7QF

(54) Refractory gas injection device

(57) A refractory diffuser, for feeding gas into molten aluminium or other fluid material at high temperatures, having a tubular inlet stem 1 in one piece with a hollow, gas-permeable outlet head 2 that extends laterally of the stem, said diffuser having secured within the stem a hollow liner 3 of impermeable ceramic and further having means for connection to a supply of gas to be passed through the liner to the outlet head.

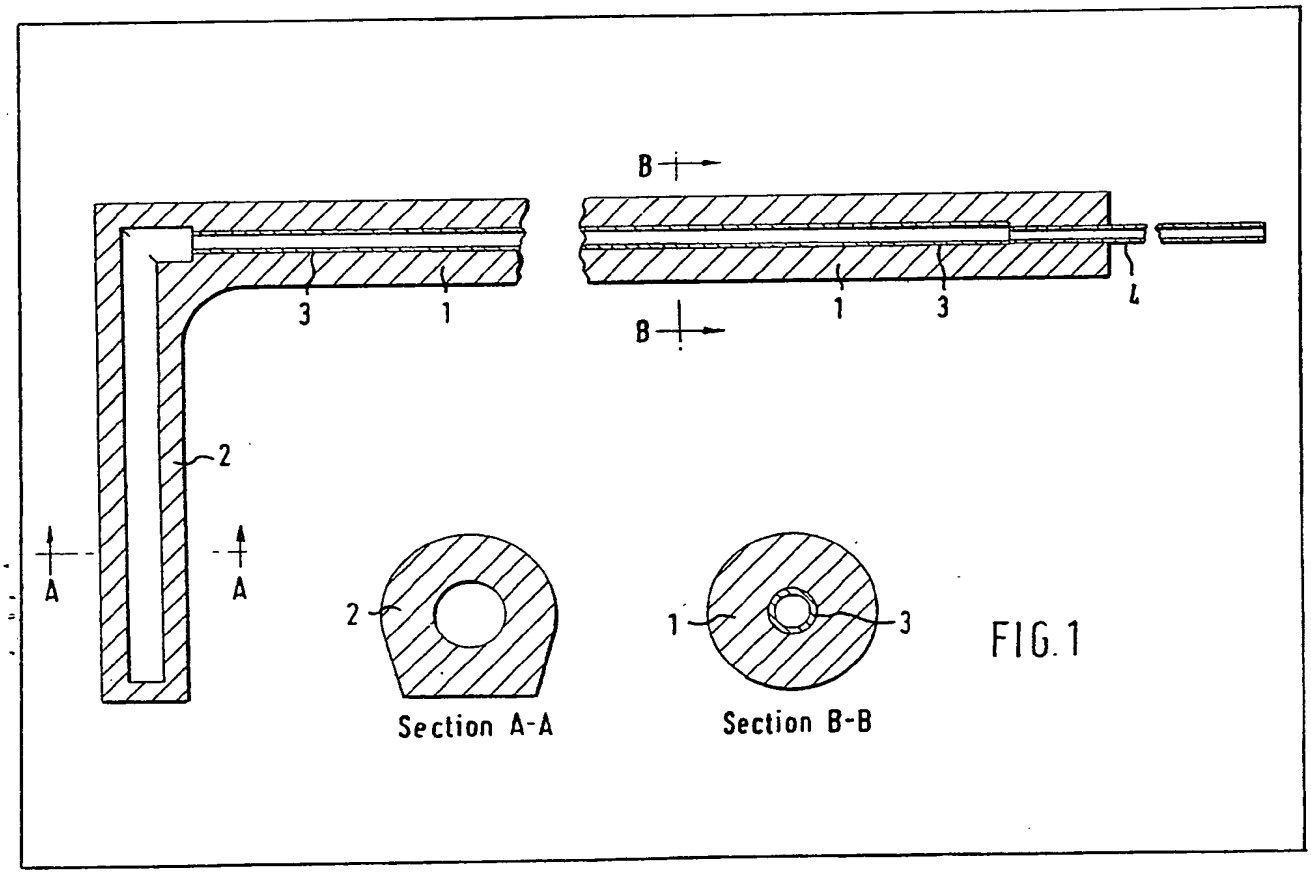

FIG. 1

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

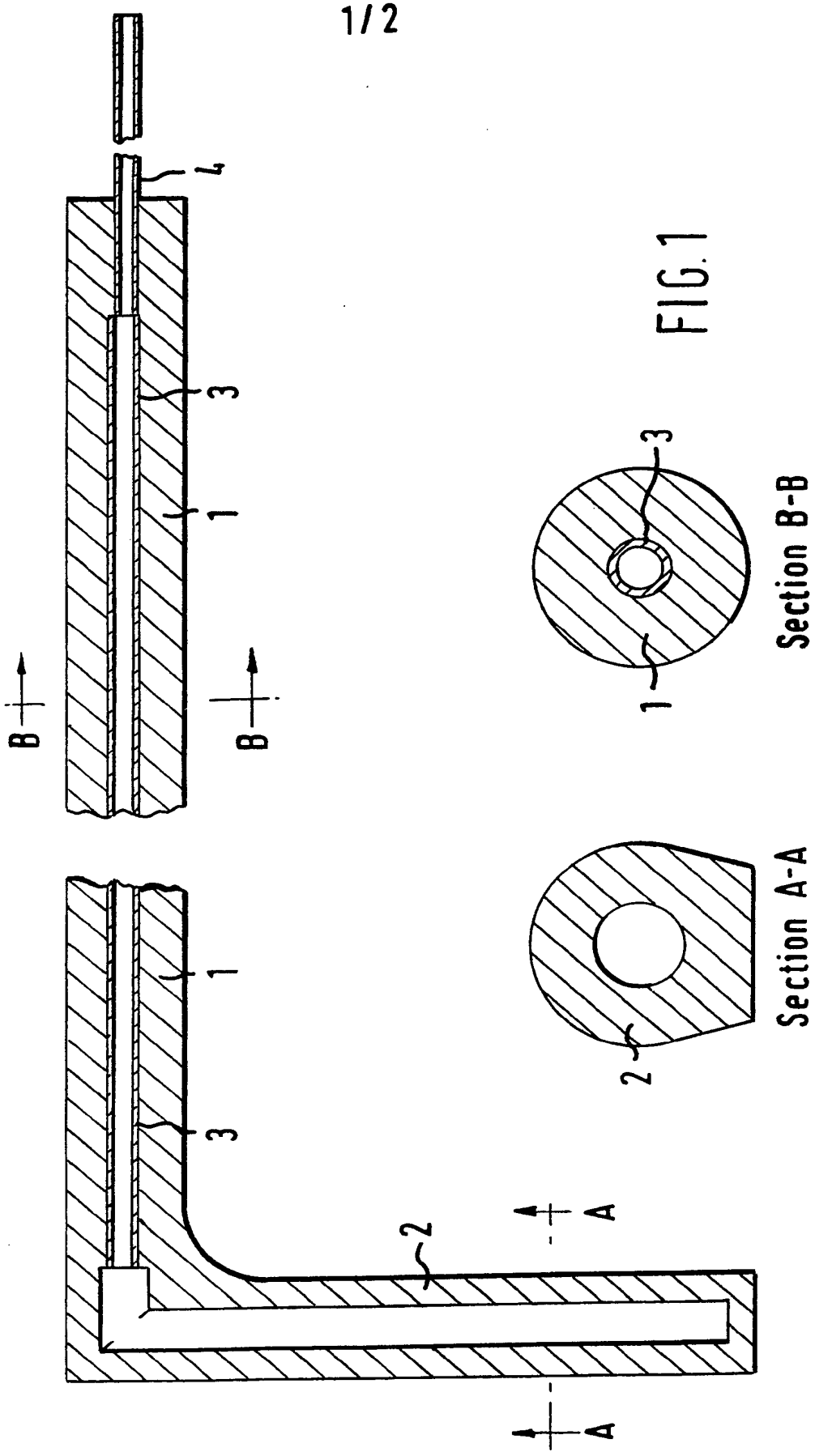

FIG.1

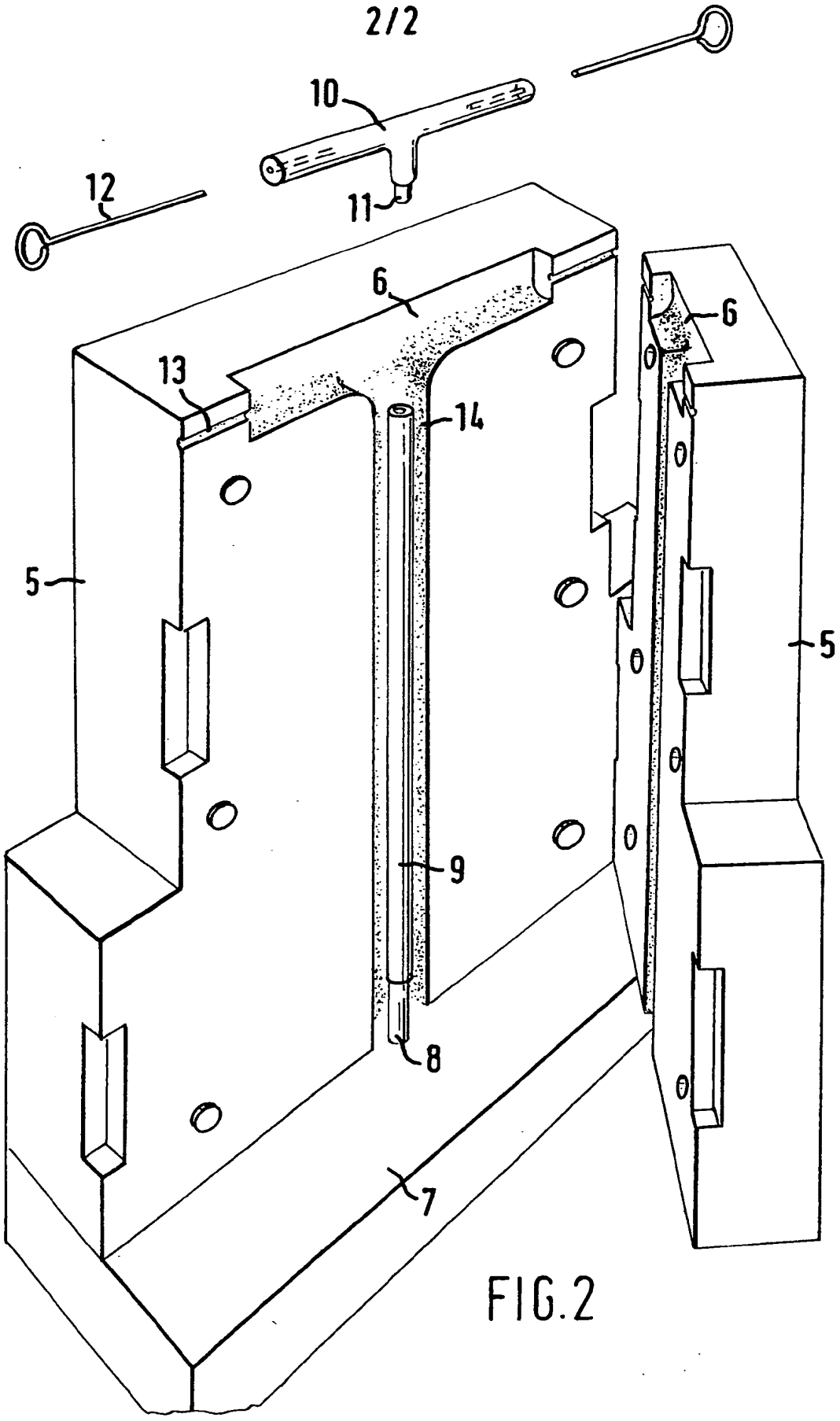

FIG.2

SPECIFICATION
Diffuser

The invention relates to the making of diffusers useful for example for feeding nitrogen into molten aluminium in a holding vessel during treatment to remove dissolved gases and impurities.

Such diffusers are described for example in U.K. specification No. 1374586 (British Aluminium Co. Ltd.) and the present applicants' U.K. Specifications Nos. 1425034 (11590/72) and 1453661 (1701/74). Their essential features are a tubular inlet stem made gas-tight such as by a liner and a hollow, gas permeable outlet head which extends from the stem to diffuse gas into the molten metal.

In the making of the diffusers it is necessary that the stem and the head should be in one piece because the conditions of service in molten metal are very severe. Any construction in which joints are exposed to the metal tends to show early failure. Thus both stem and head are of porous material and some way of lining the stem to prevent egress of gas has to be found. Commonly, metal tubes fixed mechanically within the stem have been used, meeting with reasonable success but nevertheless, owing to differential thermal expansion between the ceramic of the stem and the metal of the tube, showing inherent difficulties. Generally the metal tube has passed down the stem, bearing against the stem near its junction with the head through a flexible pad of ceramic fibre or the like and mechanically secured to the stem at its upper end, away from the head. These constructions tend to stress the ceramic and also the seal provided by the ceramic fibre tends to become imperfect so that gas passes between the metal tube and the diffuser stem and either passes into the metal where not required or leaks wastefully above the surface of the metal at the upper end of the stem.

In considering these problems we have realised that an effective answer to the provision of a non-permeable and thermally matched composite stem construction is to use, secured within the stem of a one-piece diffuser of permeable ceramic, a liner of impermeable ceramic. Means for passing gas to the diffuser are in turn secured to the stem, for example a screwed metal tube fixed by cement. The junction need not be directly with the impermeable liner, the requirement simply being that escape of any significant amount of gas through the body of the diffuser is prevented.

Suitable materials for the diffuser are for example silicon carbide bonded with carbon, alumina or clay and especially silicon carbide mixes such as described in the present applicants' U.K. Patent No. 1402988 (35977/71). These last materials are made from a particulate mix comprising zircon, alumina and silicon carbide and optionally a clay or other inorganic or organic plasticiser, the proportions and particle sizes of the zircon and alumina being such that they react on firing to give a bonding and protective matrix for silicon carbide.

The essential property of the ceramic of the stem lining is that it should be substantially impervious to the gas to be fed and preferably should have a coefficient of thermal expansion close to that of the pervious material of the diffuser. Suitable materials will be known to those skilled in the ceramics art but particularly suitable materials are impervious aluminous porcelain compositions consisting essentially of alumina Al_2O_3 and silica SiO_2.

An example of a diffuser according to the invention is shown in Fig. 1 of the accompanying drawings in which a generally L-shaped diffuser or "hockey stick" is shown, in longitudinal section and two transverse sections along the marked lines AA and BB of the longitudinal section.

The diffuser consists of a diffuser body divided into a stem 1 and a head 2, hollow throughout and made essentially by the method described in the applicants' U.K. Patent No. 1425034 using a destructible resilient core. The diffuser as a whole is approximately 40 inches (ca. 90 cm) long in the stem and 15 inches (ca. 38 cm) long in the head. A stem bore takes an impervious liner tube 3, 17.5 mm outside diameter and 12.5 mm inside diameter and, at the end away from the head, a steel tube 4 for gas supply, threaded externally and cemented into place in a bore 9/16 inch (ca. 14.3 mm) diameter. The liner is secured in place within the stem simply by being cast in place within it.

The making of the diffuser is shown, in this instance in respect of a T-shaped diffuser, in the Fig. 2 of the accompanying drawings. The mould comprises a plaster case 5 in two parts each with a half cavity 6 conjointly defining the external shape of the diffuser when the two case parts are closed. A mould base 7 has a socket for a plastic pin 8 which has a reduced end (not seen) over which one end of the impervious ceramic tube 9 is placed. The combustible core 10 has a reduced portion 11 to fit inside and locate the other end of the ceramic tube at 14, and forms the interior of the diffuser head. To ensure location and prevent any sagging of the combustible core each end thereof is bored to receive one of a pair of withdrawable spikes 12 passing through holes 13 in the mould case and withdrawn as soon as the core is sufficiently supported, to avoid weakness in the finished head. The pin 8 is withdrawn once casting is complete and leaves the socket for the steel gas supply tube.

A particular material that may be used for the liner is an impervious aluminous porcelain of the following analysis, expressed as oxides:

	By Weight
Al_2O_3	55.3
SiO_2	40.0
Fe_2O_3	0.9
TiO_2	0.9
CaO plus MgO	1.4
Na_2O plus K_2O	1.5

A preferred material for the diffuser itself is the following silicon carbide based ceramic, which has particularly good resistance to alkaline fluxes:

	By Weight
Al_2O_3	11.7
SiO_2	13.5
Na_2O plus K_2O	0.3
SiC	56.5
ZrO_2	16.7
Balance	1.3

The balance contains minor amounts (0.1% each) of Fe_2O_3, TiO_2, and CaO plus MgO, with other materials not separately analysed.

Another suitable diffuser material is the following sillimanite:

	By Weight
Al_2O_3	66.0
SiO_2	30.1
Fe_2O_3	1.27
TiO_2	0.9
CaO plus MgO	0.34
Na_2O plus K_2O	1.21
Balance	0.18

All these materials have maximum service temperatures of 1500° to 1600°C. Porosity figures (% void volume) are:

	True	*Apparent*
Impervious porcelain	16.8	<1.0
SiC-base material	16.1	15.9
Sillimanite	23.5	22.1

The coefficients of thermal expansion are:

Impervious porcelain	5.0×10^{-6} °C
SiC-base material	4.2×10^{-6} °C
Sillimanite	5.8×10^{-6} °C

CLAIMS

1. A refractory diffuser, for feeding gas into molten aluminium or other fluid material at high temperatures, having a tubular inlet stem in one piece with a hollow, gas-permeable outlet head that extends laterally of the stem, said diffuser having secured within the stem a hollow liner of impermeable ceramic and further having means for connection to a supply of gas to be passed through the liner to the outlet head.

2. A diffuser according to claim 1, wherein the stem and head are of bonded silicon carbide or of sillimanite and the liner is of an alumina/silica porcelain.

3. A diffuser according to claim 1 or 2 made by casting the stem and head about a core consisting of the liner and a destructible plastics or other body defining the interior shape of the head and lost on firing.

4. A refractory diffuser substantially as herein described and shown in the drawings.

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